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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/893,340	06/26/2001	Sien G. Kang	018419-008320US	2640

20350 7590 10/31/2003

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EXAMINER

KIELIN, ERIK J

ART UNIT PAPER NUMBER

2813

DATE MAILED: 10/31/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/893,340

Applicant(s)

KANG ET AL.

Examiner

Erik Kielin

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 26 September 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 29-42 is/are pending in the application.
- 4a) Of the above claim(s) none is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 29-42 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 10, 11.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 26 September 2003 has been entered.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims 41 and 42 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

The specification does not provide support for forming a plurality of semiconductor dice across the SOI wafer. This is new matter.

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 29-42 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Independent claims 29 and 42 recite the limitation, "said environment is about 1000 °C and greater." This is considered indefinite because it is unclear how the environment can simultaneously be at about 1000 °C while simultaneously being greater than about 1000 °C.

The remaining claims are rejected for depending from the above rejected claims.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

7. Claims 29 and 31-38 are rejected under 35 U.S.C. 103(a) as being unpatentable over 6,251,754 B1 (**Ohshima et al.**) in view of US 5,141,878 (**Benton et al.**) and **Moriceau et al.** "Hydrogen annealing treatment used to obtain high quality SOI surfaces" IEEE International SOI Conference, October 1998, pp. 37-38.

Regarding claims 29 and 42, **Ohshima** discloses a method a manufacturing an SOI substrate on which semiconductor devices are to be formed, comprising,

forming a cleaved monocrystalline silicon surface (called "detached surface" at col. 11, lines 36-56) which inherently has some surface roughness;

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high temperature annealing the cleaved surface to remove surface roughness (called “flattening the surface”) created by the cleaving process (Fig. 3, step P15; Fig. 4D-4E; col. 11, lines 50-56).

Ohshima does not teach the conditions of the anneal.

Benton teaches the benefits of doing a pre-bake anneal of a rough silicon surface in an HCl-H₂ mixture at a temperature of greater than 1000 °C -- as further limited by instant claim 37-- to “reduce native oxide films and to further smooth” the silicon wafer, wherein an exemplary anneal mixture is 0.9 liters/min HCl and 40 liters/min H₂ or a ratio of HCl:H₂ of 0.0225, which falls between 0.001 and 30, as further limited by instant claim 32. (See col. 2, lines 45-53.)

It would be obvious for one of ordinary skill in the art, at the time of the invention, to use the roughness-reducing, HCl-H₂ etchant anneal of **Benton** as the high temperature anneal of **Ohshima**, because **Ohshima** desires a native-oxide-removing, surface-flattening anneal to prepare the cleaved silicon surface for growth of an epitaxial layer, and because **Benton** provides the successful anneal conditions to provide such desired results.

Then the only difference is that the degree of surface roughness reduction is not indicated in **Ohshima**.

Moriceau discloses exposing a rough silicon surface to an etchant --which is specifically hydrogen (as further limited in instant claim 21)-- while annealing at a temperature of greater than 1000 °C to reduce the silicon surface roughness from about 50 Å to a less than 1 Å. This equates to a reduction in surface roughness of $[(50 \text{ Å} - 1 \text{ Å}) / 50 \text{ Å}] \cdot 100 = 98\%$, which is greater

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than 90%, as further limited by instant claim 31. (See whole document -- especially third paragraph and Fig. 1.)

Note also that **Moriceau** also teaches that any native oxide is also removed by this etchant anneal, at the second sentence of the fourth paragraph, which is also a desired result of the **Ohshima** high temperature anneal (col. 11, line 55).

It would be obvious for one of ordinary skill in the art, at the time of the invention, to reduce the surface roughness of **Ohshima** by an amount of at least about 90%, as taught by **Moriceau**, because **Moriceau** teaches such surface reduction enables an especially planar surface for the fabrication of semiconductor devices, which is also the object of **Ohshima**.

Regarding claim 33, as noted above in **Benton**, it is the combination of HCl and H₂ interacting with the rough silicon surface that reduces the surface roughness.

Regarding claims 34 and 38, the epitaxial chamber of **Ohshima** is a thermal processing chamber because the anneal is carried out in this environment of the chamber.

Regarding claim 35, the cleaved surface is provided by controlled cleavage in **Ohshima**. (See at least Figs 2A-2F.)

Regarding claim 36, **Ohshima** discloses that the SOI substrate is formed from a donor silicon wafer.

8. Claim 30 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Ohshima** in view of **Benton** and **Moriceau** as applied to claim 29 above, and further in view of the article **Tate et al.**, "Defect Reduction of Bonded SOI Wafers by Post Anneal Process" Proceedings of the 1998 IEEE International SOI Conference, Oct. 1998, pp. 141-142.

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The prior art of **Ohshima** in view of **Benton** and **Moriceau**, as explained above, discloses each of the claimed features except for indicating the heating ramp rate of 10 °C/second or greater.

Tate teaches a method of reducing surface roughness of cleaved SOI wafers using hydrogen etchant in a rapid thermal annealing using rates far greater than 10 °C/second. (See item entitled "3. H₂ anneal with rapid thermal annealer on Smart Cut SOI.")

It would have been obvious for one of ordinary skill in the art, at the time of the invention to modify **Ohshima** in view of **Benton** and **Moriceau**, to use high ramp rates in order to reduce the time required to smooth the surface and to reduce the thermal budget, because **Moriceau** teaches that high ramp rates should be used, and also because **Tate** specifically teaches that rapid thermal annealing works to reduce surface roughness of cleaved SOI substrates in a hydrogen-containing etchant.

9. Claim 39 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Ohshima** in view of **Benton** and **Moriceau** as applied to claim 29 above, and further in view of EP 0 553 852 A2 (**Sato et al.**).

The prior art of **Ohshima** in view of **Benton** and **Moriceau**, as explained above, discloses each of the claimed features except for indicating the pressure of the anneal for reducing the surface roughness of the SOI substrate.

Sato teaches using a hydrogen-containing atmosphere to reduce the surface roughness of a silicon surface by greater than 90% to form a planarized surface, wherein the pressure is, *inter*

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alia, atmospheric pressure, i.e. 760 Torr. (See col. 24, lines 34-51; col. 25, lines 15-32, for example.)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use 1 atmosphere of pressure during the anneal because **Ohshima**, **Benton**, and **Moriceau**, do not indicate or require any specific pressure and because **Sato** teaches pressures of 1 atmosphere as well as elevated or reduced pressure will also work to reduce the surface roughness by greater than 90% to form a planarized surface.

Moreover, Applicant has provided no evidence to indicate that the pressure during the anneal is critical to the reduction of surface roughness. Rather the instant specification teaches away from any such criticality, stating at p. 15, lines 8-9, "Chamber pressure was generally maintained at about 1 atmosphere, **but can be at others too.**" (Emphasis added.)

10. Claims 40-42 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Ohshima** in view of **Benton** and **Moriceau** as applied to claim 29 above, and further in view of Applicant's admitted prior art (**APA**).

The prior art of **Ohshima** in view of **Benton** and **Moriceau**, as explained above, discloses each of the claimed features except for indicating that the various semiconductor devices forming a circuit include a transistor.

APA teaches that it is known in the art to form transistors on SOI substrates.

It would have been obvious for one of ordinary skill in the art, at the time of the invention to form transistors as at least some of the devices of **Ohshima** as transistors in order to form

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circuits having amplifiers and switches, which are notoriously well known in the art, as taught by APA.

Response to Arguments

11. Applicant's arguments filed 26 September 2003 (Paper No. 18) have been fully considered but they are not persuasive.

Applicant argues that the art of Benton and the art of Ohshima are not related. Examiner respectfully disagrees. Both teach the need to have smooth surfaces for semiconductor fabrication and both teach high temperature anneals to achieve such smoothing or flattening. For this reason, the art is related.

In response to applicant's argument that the examiner's conclusion of obviousness is based upon improper hindsight reasoning, it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the applicant's disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971).

Applicant argues that the use of hydrogen in Moriceau is somehow fundamentally different from that used in the instant invention. Examiner respectfully disagrees. The instant specification indicates that extremely small amounts of HCl can be added to a hydrogen gas. This is not fundamentally different from hydrogen.

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Applicant argues that Moriceau gets results divergent from those in the instant application. While this conclusory observation has absolutely no bearing on the claims as presently written, this statement is factually false. The results are the same, a cleaved silicon surface is smoothed. That Moriceau does not add HCl and gets just as good smoothing, merely indicates that HCl is an extraneous additive having no special effect.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached at 703-308-4940. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Erik Kielin
Primary Examiner
October 28, 2003